Research Article

Designing Effective KPI Dashboards for ERP Systems

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ABSTRACT

ERP systems play an important role in today's business world activities. Its huge data streams in the system require an effective visualization for proper decision-making. This paper deals with the design challenges of KPI dashboards, which need to balance between data complexity and user-friendliness. In this study, a robust framework for designing KPI dashboards will be developed using a mixed-method approach that comprises systematic literature reviews, multiple case studies, and comprehensive user experience analyses. Our findings suggest that the most effective dashboards should have hierarchical structures of information, customizable views, context-sensitive visualizations, and adaptive user interfaces. We further explore how new technologies such as artificial intelligence and augmented reality will finally shape the design of dashboards. A concrete roadmap is presented for future research and development in this rapidly advancing area.

Keywords: ERP Systems, KPI Dashboards, User Experience, Data Visualization, Artificial Intelligence, Augmented Reality, Systematic Literature Review, Case Studies
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INTRODUCTION

In this digital transformation age, more and more organizations rely on ERP systems to manage sprawling business processes. The systems process a large volume and variety of data, offering potential insights critical for decision-making across all organizational levels. KPIs are crucial in simplifying these complex processes into clear, easy-to-measure outcomes that can be quickly and accurately assessed for organizational performance. The challenge, however, is one of designing KPI dashboards that can clearly present such information. In other words, it is hard to create interfaces that are at one time comprehensive and easily understandable by users with varied data literacy against a backdrop of vast amounts of data produced at a fast pace and structured in a complex way. The paper addresses the desire for agile KPI dashboards that can balance data complexity with interface usability—a dynamic equilibrium that will continuously adjust to changing user roles, contexts, and business needs. Our study shall delve into existing KPI dashboard designs across industries, determine the critical factors most influencing their effects, and create a framework for the development of high-impact dashboards. We will investigate the potentially high impact of emerging technologies like artificial intelligence and augmented reality and provide a future research roadmap in that direction.

BACKGROUND AND LITERATURE REVIEW

BI tools have become very critical in improving stakeholder engagement due to the radical change they bring about in organizational communication and presentation. They turn humongous data into user-friendly formats that a business person can get a glance at very fast to make informed decisions. Realtime insights, interactive dashboards, and options to create custom views and drill into data—these are some of the other ways in which BI tools get stakeholders more engaged with the information. The change not only opens up data but also enhances collaboration and alignment among the stakeholders toward better organizational outcomes. This introduction has therefore effectively captured the role of BI in stakeholder communications by setting the very context for the following sections.

A. Key Performance Indicators (KPIs)

Another definition of KPIs could be specific measurable values that indicate to the business how well it is doing in key business objectives. KPIs in regard to ERP generally cover quite a number of critical areas. These include financial metrics, such as revenue growth and profit margins, indicators of operational efficiency like inventory turnover and cycle time of production, metrics on customer satisfaction—Net Promoter Scores and customer

retention rates—and employee performance, like productivity and absenteeism. Indicators of supply chain management will include order fulfillment rates and supplier performance. Under innovation and growth metrics, there could be new product development cycle times and R&D spending. On the last note, there are sustainability and compliance measures that entail carbon footprints and regulatory compliance scores. According to Parmenter, 2015, KPIs can be classified into two categories: the leading indicators, which are predictors of future performance, and the lagging indicators that make out the past performance [1]. Both types are essential for a comprehensive understanding of organizational performance.

B. ERP Systems and Dashboard Integration

ERP systems enable a single platform to be at the root of various business processes, thus delivering one version of truth for organizational data. Virtually all modern ERP solutions include a dashboard component, providing real-time insight into business performance and acting as a focal point for the monitoring of KPIs across different departments. Chofreh et al. (2018) pointed out that among the basic roles of ERP systems in organizations is the enhancement of data-driven decisionmaking using dashboards that can translate such complex data into actionable insight [2]. However, the challenge of interface design that properly represents multi-dimensional data without overwhelming the user still stands. Of late, especially with the integration of Internet of Things devices and big data analytics, the complexity of data that is to be presented on a dashboard has surged [3].

C. User-Centered Design Principles

Effective KPI dashboards should leverage user-centered design. Some of the key principles relevant to dashboard design that Norman identifies include visibility—what's important in controls and information should be easy to see; feedback—what happens as a result of user action should be clear and occur in real-time; constraints—what the user can do is constrained to catch user errors and to simplify interaction; mapping—controls are logically related to their effects in the system; consistency—similar things should behave similarly throughout the interface; affordances—the methods of interacting with the interface should be clear [4]. These principles ensure intuitive and user-friendly dashboards. Moreover, Schneiderman's (1996) "Information Seeking Mantra" suggests overview, zoom and filter, and details on demand [5]. This strategy fits very well with the hierarchical character of KPI dashboards in ERP systems.

D. Data Visualization Techniques

Proper data visualization is necessary for KPI dashboards. The elements of graphical excellence by Tufte, 2001, are about clarity, precision, and efficiency in statistical graphics [6]. Showing comparisons, contrasts, and differences; illustrating causality, mechanisms, and systematic structures; multivariate data displays; integrating words, numbers, images, and diagrams; thorough description of the evidence; and content taking precedence over everything else - these are key principles that need to be adhered to. Recent developments in this respect include interactive and animated visualizations, which make it possible to represent complex data of KPIs more engagingly and intuitively (Heer & Shneiderman, 2012) [7].

METHODOLOGY

In this respect, our research adopted a rigorous mixed-method approach to address existing challenges in the design of effective KPI dashboards for ERP systems. The methodology consisted of four major components:

A. Systematic Literature Review

In our detailed research on literature reviews and online publications available, we paid special heed to the aspects of KPI dashboard design, user experience within ERP systems, and data visualization techniques. As prescribed by the systematic review guidelines, specially tailored for software engineering by Kitchenham in 2004 [8], we established a structured approach for this: We fished in databases such as IEEE Xplore, ACM Digital Library, ScienceDirect, and Scopus using keywords like "KPI", "Key Performance Indicator", "Dashboard", "Visualization", "ERP", "Enterprise Resource Planning", and similar others. We hence covered mainly publications from 2010 to 2020 and further limited ourselves to peer-reviewed journal articles, conference papers, and good white papers from industry sources. The inclusion criteria were relevant to KPI dashboard design within ERP systems, usability, user experience in business intelligence interfaces, and applicable data visualization techniques. Non-English publications and those that were strictly technical, not covering dashboard design, were excluded. After initial identification of 1,247 papers, we narrowed this down to 183 after the rigorous application of criteria, from which we extracted key themes and best practices.

B. Multiple Case Studies

We have included eight real-world case studies of KPI dashboard implementation across various industries. They are:

Manufacturing: Global automotive parts supplier

Healthcare: Regional hospital network

Retail: International e-commerce platform

Financial Services: Multinational investment bank

Logistics: National courier service provider

Energy: Renewable energy company

Education: Large public university

Technology: Cloud services provider

For all these cases, we elaborated on dashboard design and layout, KPI selection and presentation methods, users' feedback, adoption rates, integration into the existing ERP workflows, and problems faced and solutions applied. Data collection methods included semi-structured interviews with key stakeholders, internal documentation analysis, on-site observations of the use of dashboards, and performance metric reviews prior to and after the implementation of the dashboards.

C. User Experience Analysis

In summary, it involved an extensive user experience study with 100+ ERP users from various roles and industries, with a response rate of 68% for the online questionnaires distributed, complemented by in-depth interviews with multiple ERP users, from executives and managers down to operational staff. It included various participants in usability testing for the evaluation of various dashboard designs and interaction patterns, supplemented by eye-tracking studies with various participants to explore how visual attention varies with different dashboard layouts. The analysis has been done about user preference vis-a-vis layout, design, information hierar-` chy, navigation patterns, options for personalization, mobile accessibility, integration into daily workflows, cognitive load, and satisfaction of users about dashboards.

D. Prototype Development and Evaluation

General insights obtained from the literature review, the collection of case studies, and a more focused user experiencebased analysis showed the development of several prototype KPI Dashboards. Several evaluations have been conducted through Heuristic Evaluation by five UX experts and five ERP System Domain Experts and task-based usability testing with 40 representative various user roles and A/B testing with the comparison of different design components and patterns of interaction. This phase was important to fine-tune our design recommendations and validate our proposed framework for KPI dashboard design to meet requisite technical and usability standards for effective deployment in diverse enterprise environments. Our results have important implications for the design of KPI dashboards, but they have some limitations because case studies mainly come from North America and Europe and, consequently, they might not generalize well to other regions with different economic and technological landscapes. In addition, it might be such that the diversity of ERP systems, together with their custom configurations, will impact the universality and applicability of our proposed design principles.

RESULTS AND ANALYSIS

A. Literature Review Findings

Our systematic literature review revealed several key themes in KPI dashboard design:

1. Information Overload: Several studies, as early as Yigitbasioglu and Velcu (2012), pointed out the risk of information overload in complex dashboards due to the necessity of careful selection and hierarchical presentation of KPIs [9].
2. Customization: Research by Pauwels et al. (2009) and Eckerson (2010) pointed out the need to include a customized dashboard to cater to the different user roles and preference. The research depicted that customizable interfaces enhance user satisfaction and perceived usefulness [10][11].
3. Visual Design: Evidence-based best practices for proper choice of chart types and color schemes in sound data visualization in dashboard contexts came from studies by Lempinen, 2013, and Knaflic, 2015. Ware, 2012, emphasized the role of preattentive processing in dashboard design [12][13].
4. Mobile Accessibility: Recent literature contributed, for example, by Allio, 2012 and Sarikaya et al., 2018 commented that more emphasis needed to be placed on mobile-friendly dashboard design, as a function of changing work patterns and technology usage. Reports indicated that dashboard use increased by 30% when mobile-optimized versions were made available [14][15].
5. Real-time Data: Several studies, for example by Dinter & Lorenz, 2012 stressed the need for real time, or nearreal-time refresh of data used in KPI dashboards, notably in operational decision-making [16].
6. Cognitive Fit: Early work of Vessey & Galletta, 1991, and others pointed out the need for using types of visualizations fitting the cognitive processes of users and of their nature in performing tasks [17].
7. Adaptive Interfaces: More recent work—for example, Dabbebi et al., 2017—has explored the role and promise of adaptive dashboard interfaces that adapt automatically depending on user behavior and context [18].

We did hit upon certain conflicting data, specifically on user satisfaction metrics between industries. For example, while retail sectors indicated very high satisfaction with real-time data features, their health sector counterparts were less enthused, likely due to different priorities and regulatory concerns. These discrepancies show nuanced needs across industries that must be considered in dashboard design.

1) Case Study Analysis

Of the eight different case studies analyzed, the following are some of the key factors that have contributed towards the successful implementation of KPI dashboards. One such important factor is stakeholder involvement. In fact, in all the successful cases, it has been believed that engaging key stakeholders in the designing phase of the dashboard

is crucial. This helps to ensure the dashboards meet business objectives and user needs, which tends to increase user adoption by 40% compared to less involved approaches.

Another big factor was an iterative design process. Those who used an iterative approach to dashboard design—characterized by frequent user feedback and constant refinement—saw much higher user satisfaction, 4.2 on average out of 5, and a strong adoption rate of 72%. In contrast, using a more static approach resulted in a satisfaction rating of 3.1 out of 5, on average, with a much lower adoption rate of only 45%. Moreover, dashboards that fit seamlessly into the current ERP workflows not only experience an increased number of daily uses as compared to 1.8 for the nonintegrated ones, but users perceive such as more valued.

Successful dashboards were those that balanced the need for showing high-level KPIs for ease of use with the ability to drill down into greater detail. Most of the dashboards showed 7–10 high-level KPIs by default. Responsive design, making it accessible on multiple devices, increased this rate significantly as well—to the case of executive user base, which grew 68% in the usage rate.

Data quality and reliability also play a major role in the success of KPI dashboards. If an organization has high quality and reliable data within their ERP systems, then users will have more trust in the dashboard KPIs and will start to use them at an increasing rate for any decision-making purposes. Thorough training and ongoing support increase the velocity of adoption by users and increase satisfaction so that the tools of the dashboard can be used more quickly and more efficiently.

Table I: Case Study Analysis: Key Factors and Improvements

Factor	Improvement
Stakeholder Involvement	40% higher adoption rates
Iterative Design	Satisfaction: 4.2/5 vs 3.1/5, Adoption: 72% vs 45%
Integration with Existing Workflows	Daily usage: 3.5 vs 1.8 times/day
Balanced KPI Selection	Balanced high-level KPIs: 7-10
Responsive Design	68% increase in usage
Data Quality and Reliability	Higher trust and utilization
Training and Support	Enhanced adoption and satisfaction

B. User Experience Analysis Results

In our full user experience study, there were some key usability findings around dashboard usage. Actually, the vast majority—78% of users preferred dashboards that displayed fewer than 10 high-level KPIs on the main view, with options then to drill down for more detailed information. Eye-tracking studies showed that about 60% of the users' time was spent viewing the top five KPIs. Also, a strong majority, 92 percent, said that the ability to customize one's view of a dashboard was important, and 35 percent higher satisfaction was found among the users who used customizable dashboards. Another critical factor was mobile usage: 65% of users access dashboards on mobile devices at least weekly. This reiterated the importance of responsive design, as mobile-optimized dashboards see 47% higher engagement rates. Very clearly, there was a user preference for interactive charts and graphs over static tables in the presentation of KPI data. In addition, 87% preferred interactive visualizations to be more effective for quick data interpretation. Heat maps and treemaps turned out to be especially effective in the display of hierarchical KPI data. On the other hand, benchmarks and historical trends—contextual information required by 73 percent of users—increased time spent on the analysis of data by 28 percent. Additional requirements needed were real-time or near-real-time refreshes to data on the dashboard, specifically operational KPIs, as required by 68 percent of users. Real-time data enables 23 percent faster decision-making. Lastly, intuitive navigation was important, and 89 percent of all users preferred a hierarchical structure that allows for easy navigation between high-level overviews of metrics and detailed drill-downs. Seventy-six percent of the respondents considered proactive alerts on the threshold breaches of KPIs to be most valued, and 52% higher engagement was made in those dashboards with built-in intelligent alert mechanisms. Over half of the users, 61%, wanted native in-dashboard collaboration tools, improving team alignment on KPI interpretations by 29%. A well-designed dashboard reduced the cognitive load by 42% compared with a poorly designed interface, making S&D faster and more accurate.

Table II: User Experience Analysis: Key Insights and Impacts

Insight	Percentage	Impact
Information Density	78%	Focus on top 5 KPIs
Customization	92%	35% higher satisfaction
Mobile Usage	65%	47% higher engagement
Data Visualization	87%	Preferred interactive charts
Contextual Information	73%	28% increase in analysis time
Update Frequency	68%	23% faster decision-making
Navigation	89%	Prefer hierarchical structure

Alerts and Notifications	76%	52% higher engagement
Collaboration Features	61%	Improved team alignment by 29%
Cognitive Load	42%	42% reduction in cognitive load

C. Prototype Evaluation Results

Testing of our prototype dashboards provided helpful feedback for its fine-tuning. Dashboards use adaptations to a user's role and access pattern to allow improved task completion time by 31%. Enhanced filtering capabilities allowed the user to locate relevant information 45% faster than comparative, noninteractive static choices. In the revised dashboard, consistent color-coding of KPI statuses increased KPI status recognition by 28%. Embedding narrative components to guide the user through the interpretation of KPIs improved comprehension of the more complex metrics by 39%. Testing voice-activated queries showed high potential for hands-free type interaction, with 67% of users rating this feature as helpful to see KPIs onthe-go. It was revealed from the reviews that desirable properties of effective KPI dashboards should include adaptability, interactivity, and user-centered design.

Table III: Prototype Evaluation Results: Improvements

Evaluation	Improvement
Adaptive Layouts	31% faster task completion
Interactive Filtering	45% faster information location
Consistent Color Coding	28% better KPI status recognition
Narrative Visualizations	39% better comprehension
Voice Interaction	67% found helpful

PROPOSED FRAMEWORK FOR KPI DASHBOARD DESIGN

Drawing from extensive research, we now present the comprehensive framework for development of effective KPI dashboards in ERP systems, elaborated as follows:

1) User-Centric Design Process

The development and implementation of the dashboards will have structured methodology, involving stakeholder analysis, KPI selection, iterative prototyping, and continuous improvement. Stakeholder analysis will be conducted by firstly identifying critical user groups such as executives, managers, and operational staff. These could be reached through interviews and surveys in order to outline specific needs and challenges in creating user personas and use cases particular to each one of them. Second, KPI selection involves working with the relevant stakeholders in respect to each user group that will make sure that the KPIs relevant to them are aligned with broader business goals. It is important, at this stage, to not have more than 7-10 KPIs at a high level in order not to lose clarity and focus. Following this, iterative prototyping starts with lowfidelity wireframes for testing concepts; proceeds to interactive prototypes using the right tools. Conduct usability tests with representative users; based on feedback and measured metrics, refine the design. Continuous improvement is marked by the use of analytics to track dashboard usage and the formation of trends. User feedback via surveys and interviews happens regularly. Review and refresh processes are in place for KPIs and dashboard designs. Such a comprehensive approach ensures dashboards are effective, user-centered, and aligned with organizational objectives.

2) Information Architecture

An effective information architecture is one of the basic steps to create a user-friendly and functional dashboard. Arrange KPIs in a clear hierarchy so the user can drill down from highlevel overviews to details, with intuitive navigation systems that enable smooth transitions between the different levels of data. This is very important for role-based views: by default, the dashboard views should be role-specific, and users with disparate responsibilities should be able to toggle through various views with ease. It enhances user experience by customizing layouts, allowing users to personalize the dashboard layout; it also provides an ability to choose KPIs and arrange them within constraints in such a way that best suites them. Furthermore, the relevance of it is added by the integration of benchmarks, historical trends, and targets at the KPI level and ensures understanding by providing tooltips or explanatory texts for complex metrics, and thus users can make an informed decision based on the data presented.

3) Visual Design

A visual design in a dashboard is very integral to creating effectiveness and ease of use. This calls for clarity and simplicity through clean and spacious layouts, with an adequate amount of white space and a grid that allows consistency in laying out the elements to be on the dashboard. Proper selection of appropriate visualizations is critical at this stage; the type of visualization should be selected to best represent the nature of each KPI measure—for instance, line charts for trends and bars for comparisons. Advanced visualizations, like heat maps or treemaps, should be used only when appropriate and with a user guide. Also, there is a need for consistent coloring in order to have a logical color palette that helps interpret the data, such that the colors are used consistently to represent good, bad, or neutral performance, while making sure there is enough contrast for accessibility. Another equally important aspect is responsive design: making sure dashboards resize well on various screens of devices and improving touch

interactions for use on mobiles and tablets. By considering the principles of visual design, dashboards can be created that are more intuitive, engaging, and accessible across a number of platforms, thus improving the user experience and enhancing the ability to understand data better.

4) Interaction Design

In an effective dashboard, interaction design is a must-have component. It should be engaging and easier to use; that is, it needs intuitive navigation with clear and consistent navigation facilities across various views of dashboards and detail levels, oriented by cues like breadcrumbs to let users know where they are. Interactive elements in visualizations enable engagement and the exploration of data through such features as hover effects, tooltips, and clickability for details. Dynamic filtering and data sorting make it easier to conduct a better level of analysis within their visualizations. Strong search and filter capabilities will be required to quickly find specific KPIs or data. Save search or bookmarking functionality should be in place for easy access. It provides a KPI alert system, allowing users to be kept up-to-date on critical changes. Alerts and notification settings can also be adjusted according to the liking of users. Following these interaction design principles, more intuitive, responsive, and user-driven dashboards will be developed, thus improving the overall user experience while giving way to easier data analysis and decision-making.

5) Performance and Integration

The optimum performance and perfect integration of the dashboard guarantee effectiveness in its functioning. Systems Near real-time or real-time ones, updating data with clearly denoted freshness and update intervals will ensure that information is current and relevant. Efficient data retrieval is ensured by database query optimization, caching strategies for improving speed at loading the dashboard, and progressive loading techniques handling huge sets of data. This includes integration with any existing ERP workflow and organizational data sources, SSO capabilities for easy access to various systems, and security in data and compliance. Indeed, there is a need to enforce role-based access controls so that the visibility of data is restricted only to authorized users. It should ensure adherence to relevant protection laws on user data, such as GDPR and CCPA. It is with a view of these performance and integration principles that a dashboard can be enabled to offer timely, safe, and efficient data access for improved user experience and operational efficiency.

6) Adaptive Intelligence

Adaptive intelligence is one of the most important features in building advanced and responsive dashboards. By employing machine learning algorithms, these would provide prediction insight with anomaly detection, while AI would give recommendations for relevant KPIs to user roles and patterns of behavior. Integrating natural language processing empowers users to intuitively query their data conversationally, while automated insight generation flags important trends and anomalies. It also personalizes by dynamically changing the layout of dashboards and their content in accordance with a user's preference and activity patterns. It smartly recommends KPIs and reports to drive decisions. This would be adaptive intelligence that would ensure intelligence in a dashboard, being responsive and also individual-centric.

This is a framework that outlines the creation of KPI dashboards that are not only functional but also intuitive, engaging, and able to adapt continuously to the changing needs of the modern enterprise.

DISCUSSION AND FUTURE DIRECTIONS

Our research thus underscores the challenge of KPI dashboard design for ERP systems: finding the right step in balancing its complexity and usability. The proposed framework, in that sense, attempts to fill the gaps existing in the literature and in practical implementation of the same through a holistic approach in building effective yet user-friendly dashboards.

A. Emerging Technologies

AI and machine learning will reinvent dashboards through predictive analytics, anomaly detection, and personalized insights. In the future, research in the domain of integration of AI-driven features that learn from user behavior and dynamic business needs will be highly sought after. Natural language processing can enable more natural interaction with the dashboard, whereby users may ask questions to the data and get insights back in natural language. In this vein, further research could be conducted on how NLP interfaces can best optimize user engagement and decision-making. AR and VR could further be advanced to quite literally plunge users into data visualization experiences, hence letting them behave with KPIs in truly new ways. More concretely, it is necessary to carry out research related to practical implications of AR and VR in the KPI dashboard design within those industries that need complex data analysis.

B. Cross-System Integration

In such respect, holistic performance monitoring would mean the integration of KPI data from a number of ERP systems and external sources. It would be able to provide a full overview of the performance of the organization. Dashboard design should correlate with developing frameworks that assist both seamless cross-system integration and data harmonization. Data privacy and security in such a connected and rich data environment become very important. Further research has to be focused on the challenges of preserving data integrity, compliance, and user trust in such advanced dashboard systems.

C. User Experience Enhancements

Adaptive user interfaces would make KPI dashboards adapt to the different roles, user preferences, and behavior, further improving usability and relevance. One of the key areas of future study is to investigate how adaptive design contributes to user satisfaction and performance. The incorporation of collaboration features among members can help improve team alignment and decision making. It needs to be answered by research on how far collaborative features in a dashboard increase its utility through shared annotations and real-time data sharing.

D. Practical Implications

The findings provide key implications for both the ERP system designers and the firms implementing KPI dashboards. Implicitly, User Centered Design is the one wherein the users are involved in the whole design of the dashboards from the concept to on-going refinement. Customization and Flexibility in the dashboards must be able to balance between standardization for consistency and customization to accommodate the various user requirements. Data Quality and Integration are critical for dashboard effectiveness and user trust. Continuous improvement mechanisms on constant user feedback and dashboard refinement are required for long-term success.

E. Limitations and Future Research

While our study swept across multiple industries, focused studies on particular sectors will bring out unique challenges and best practices. The geographic scope of our case studies was mainly in North America and Europe; further research on the design of KPI dashboards should be conducted in other regions to consider possible cultural and economic differences. Longitudinal research would help compare dashboard use and effectiveness over time. Further research in the practical field of AI, ML, and AR/VR usage with KPI dashboards is necessary. Such future studies could investigate how AIdriven insights into the data would interact with decisionmaking quality and speed in different organizational contexts, how to effectively balance automated versus human-driven customization in adaptive dashboard interfaces, cultural factors in KPI dashboard design preferences and effectiveness in different global regions, and the long-term impact of putting collaborative features into KPI dashboards on overall organizational performance and team dynamics.

CONCLUSION

Proper KPI dashboards for ERP systems should balance the data's complexity on one hand with user-friendly interfaces on the other. We bring forth evidence that successful dashboards will be those to express complex data intuitively, be customizable, and context aware. Following the user-centered design principles and our proposed framework, we can help organizations create dashboards that provide relevant insights while keeping high usability. Integration of such emerging technologies like AI and ML opens promising ways toward the enhancement of dashboard functionality and users' experience. At the same time, the rapidly changing nature of ERP systems and data visualization techniques demands further research and adaptation. Further research in this area might deal with long-term effectiveness, industry-specific solutions, and integration with advanced technologies, including augmented and virtual reality.

One of the key challenges in this research was meeting the different needs across user groups. For example, simplicity was at the heart of operational staff needs, whereas executives required comprehensive views. This helped refine our framework for serving diverse needs.

Well-designed KPI dashboards are critical to help bridge the gap between very complex, data-driven information systems and human decision-makers. Next-generation dashboard design will be about creating even more intelligent, adaptive, and immersive data visualization experiences that can keep pace with evolving business requirements in our data-rich world.

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